PHYSICS

Physics is about explaining phenomena by

- Measuring quantities and making observations
- Using measurements and observations to explain / describe phenomena
- calculate quantities
- predict

Counting

- how many "things"
- usually whole numbers

Measuring

- involves quantities (value)
- usually has decimals
- needs significant figures

Measurement is a physical quantity. It is made up of two parts: a number and a unit. eg. 10m means 10 times meters.

Quantities / Units / Symbols

Quantity is something you can measure eg. m , t , v

Unit is how you measure it , what you measure it in (SI units are standard international units) eg. g , km , s , m^3

It usually makes sense to have the unit after the number.
eg. 5s (5 seconds)

Symbol is a shortened form / abbreviation for the unit or the quantity or equipment.

Combining units

A girls cycles 15 m in 3 s. Therefore she travels 5 m every 1 second. Her speed is thus 5 ms^{-1}. The equation for speed is therefore derived from the definition:

Speed = distance per unit time

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

Basic S.I Units

Quantity	Name of unit	Symbol of unit
Length	metres	m
Time	seconds	s
Mass	kilogram	kg
Electric current	ampere	A
Temperature	Kelvin	K
Quantity of substance	mole	mol

Common non S.I. unit quantities

Tonne (mass) 1t = 1000 kg

Litre (volume) 1L = 1000 mL = 0.001 m^3

Hour (time) 1 h = 60 minutes = 60x60 seconds = 3600 s

1 min = 60 s

Degrees celcius (temperature) 1 °C = 1K ; 0 °C = 273K

Prefix of unit	meaning	abbreviation
G (giga)	10^9	GW (gigawatt)
M (mega)	10^6	MW(megawatt)
k (kilo)	10^3	kg (kilogram)
d (deci)	10^{-1}	dm (decimeter)
c (centi)	10^{-2}	cm (centimeter)
m (milli)	10^{-3}	mg (milligram)
μ (micro)	10^{-6}	μm(micrometer)
n (nano)	10^{-9}	nm (nanometer)

Using prefixes

1. 2m = ________ mm

= ________ km

= ________ μm

2. 2400g = __________ μg

= __________ mg

= __________ kg

3. 0.0076s = ___________ ns

= ___________ ms

= ___________ μs

Challenge

4. 15ms = ________ μs

0.031kg = __________ mg

29300cm = __________ km

Converting common units

- **Mass:** 1 tonne = 1000kg — To convert: **kg → g X 1000**
  1 kg = 1000g — **g → kg ÷ 1000**

- If the unit gets smaller then the number gets bigger.
  1g = 1/1000 (10^{-3}) kg

If the unit gets smaller then the number gets bigger.

- **Distance:** 1 km = 1000m
  1m = 100cm ; 1cm = 0,01m (10^{-2})
  1m = 1000mm ; 1mm = 0,001m (10^{-3})

- **To convert** **m → cm X 100** — **m → mm x 1000**
  cm → m ÷ 100 — **mm → m ÷ 1000**

- **BIG → small** m → cm c (10^{-2}) thus 3m = 3 x 10^{2}cm
  km→m km (10^{3}) thus 2km = 2 x 10^{3}m

- **Small → BIG** mm → m m (10^{-3}) thus 7mm = 7 x 10^{-3}m
  m → μm m (10^{6}) thus 8m = 8 x 10^{-6}μm

Converting non SI units

Temperature

1. room temp. ______°C = ______K
2. T of boiling water ______°C = ______K
3. Freezing point of H_2O ___°C = ______K

Volume

1. 1 cup = 250 mL = ______L = ______m^3
2. 0.5 L = _______cm^3 = ________m^3
3. 20 000 L = ________m^3 = ________mL

Mass

1. 703 kg = ________t
2. 4.6 t = _________kg

Time

1. 25 h = ______min = _______s
2. 60 000 s = _______min = ______h

= ______ h ____min ____s

Ordinary Form

This is a normal number eg. 732 (3sf)

The number of significant figures can sometimes be unclear eg 2700 can be 2sf or 3sf or 4sf (if stated).

Standard Form (scientific notation)

This is generally used because the numbers are too large or too small to write out in full.

Eg. 270 000 000 = 2.7×10^8 (two significant figures)
0.000 000 715 = 7.15×10^{-7} (three significant figures)

Standard form (sci notation) has one number, then decimal point, then rest of number, then $\times 10^x$

Standard form is often required to a certain number of significant figures (sf) and is a more accurate way to show the number of sf.

In standard form 2.7×10^3 (2sf) ; 2.70×10^3 (3sf) ; 2.700×10^3 (4sf) show clearly the number of sf.

Significant Figures

- This represents the total **number of digits** that can be correctly used to represent a value.

- **Zero** is **not** always **significant.**

- The **zero is significant**

  - when it is between other digits eg. 503 (3 sf)

  - when it is at the end of a number and after the decimal point

    eg. 87.90 (4sf)

- The **zero is not significant**

  - when it is at the front of a number eg. 0.00419 (3 sf)

  - at the end of a number with no decimal point (unless stated)

    eg. 80500 (3 sf)

- An **answer** is always given to the **least number** of significant figures of the data in a calculation.

Standard / Ordinary form

Write in standard form

43 200

1 000 000

0. 0078

0. 000 000 000 495

60800

0.00103

1008100

0.0004017

Write these values to 3 significant figures

Scientific notation

Write in ordinary form

4.3×10^{3}

7.09×10^{4}

2.41×10^{-3}

4.8×10^{-5}

3.09102×10^{-7}

7.00403×10^{8}

6.023×10^{23}

1.2×10^{-9}

Write these values to 2 significant figures

Measurement and significant figures

Multiplication and division and powers and roots

- Round the answer to the least number of sig. figs of the numbers used
- Eg. Calculate the area of a block 3.2m by 0.341m.

A =

Adding and subtracting

- Before adding or subtracting the data round to correct number of decimal places

Eg. Calculate the perimeter of block above.

P =

Constants in an equation

- Ignore sf of constant when calculating

eg calculate the kinetic energy of a 5.27kg rock travelling at $6.1ms^{-1}$

$E_k = \frac{1}{2} mv^2 =$

Angles and trig ratios

- Keep the same number of s.f. between angles and their ratio

eg. $\Theta = 45^{o}$ (2sf) ; $\sin\Theta = 0.71$ (2sf)

$\tan\Theta = 0.458$ (3sf) ; $\Theta = 24.6^{o}$ (3sf)

Subtraction

- Accuracy is reduced when subtracting numbers that are approx. the same size
- Number of sig figs can reduce (this is not ideal)

Eg. 5.24 – 4.98 = 0.26

(3sf) (2sf)

Order of magnitude

- Quick estimate
- Normally powers of "ten"
- Eg. about a million ($= 10^{6}$)
- Mass of e^{-} is about 10^{-30}kg

Maths Processes - using equations

- Do 1st - x^y or $y\sqrt{x}$
- Then - $\times$ or $\div$
- Then - $+$ or $-$

Rearranging the equation :

do it in the reverse order

Uncertainties

- Nothing can be measured exactly - there is always an uncertainty (NOT a mistake)
- When expressing a measured value either

  value ± uncert plus unit

  Or value unit ± uncert.
- When reading a scale ± 0.5 x smallest division.
- When making a measurement

  ± smallest division (0.5 at each end)
- In a calculation

+ or -	Σ uncertainty
x or ÷	Σ % uncertainty
x^n	% uncertainty x n
$x^{1/n}$	% uncertainty x 1/n

Errors and uncertainties

Measurements are never accurate

Systematic errors – constant error

eg. friction, error of parallax, zero error.

Random errors – you have no control

- need better equipment
- values will vary

Accurate = correct ; **Precise** = same value

Significant figure in uncertainty

- Uncertainties should always be expressed to 1 sf.
- The uncertainty in a measurement should be sensible
  eg. 2.063942 $\pm$ 0.01 is as useless as 24 000 $\pm$ 0.002
- When measuring a distance d as 1.721 $\pm$ 0.025 m

Procedure i) uncert 1sf 0.03

ii) reflect uncert in answer

1.72 $\pm$ 0.03 m

Vernier Scales

- A vernier scale
  - increases accuracy
  - allows one more sig. fig than the main scale normally would.

- Vernier scales can be read to the accuracy of the smallest division of the vernier scale

Scientific Method

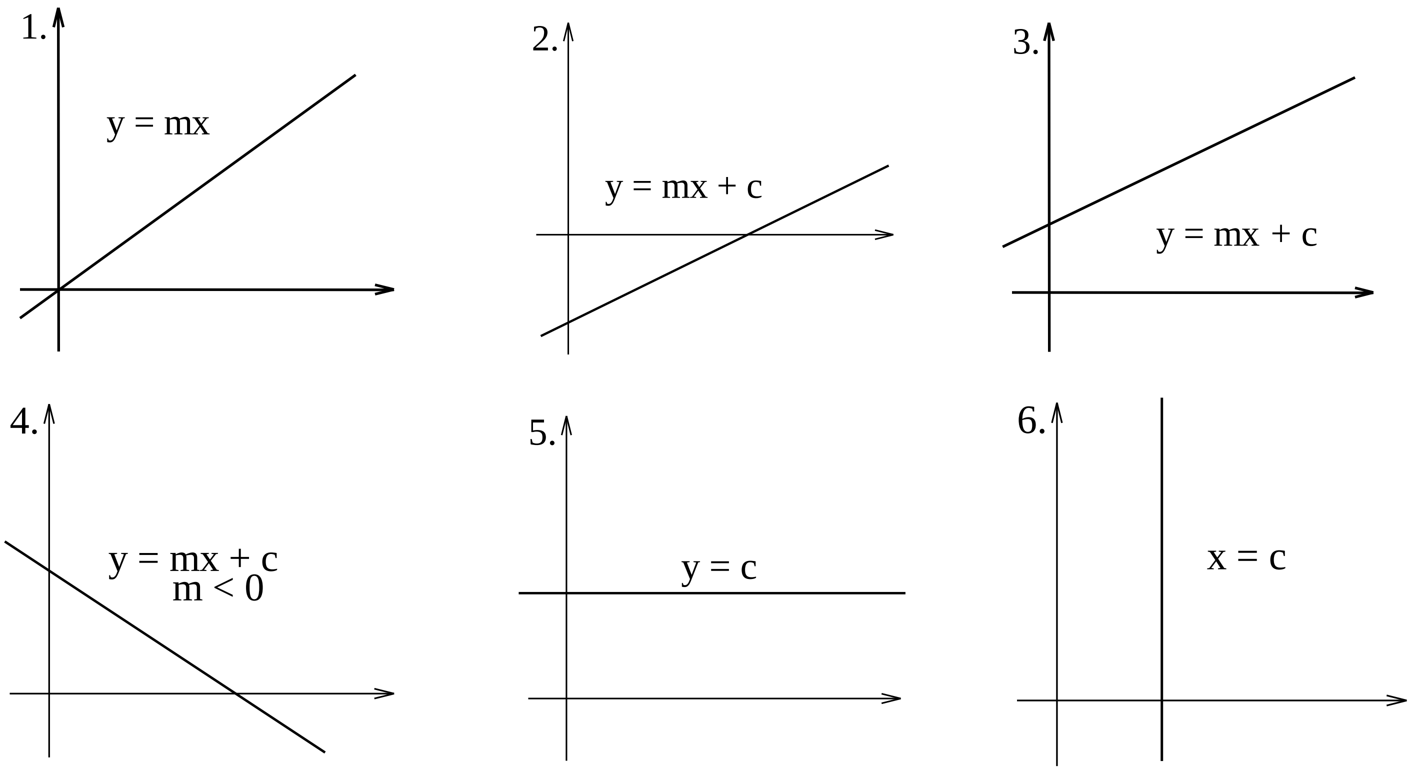
- **Aim:** sets the purpose , asks rhetorical question.
- **Method:** what to do , in words and/or a diagram
- **Results:** Measurements and Observations
  Tables are a clear way of showing data –
  rule, quantity and unit
- **Processing:**
  Calculations – formula , substitution , answer, unit sig fig.
  Graphs - axes - quantity , units, scale
  - points with a cross (x) not dot.
  - Smooth single line, if it looks straight rule 1 line
  - Interpolate means to read values between the data range
  - Extrapolate means to read data outside the data range
  - Gradient = $\frac{\Delta y}{\Delta x}$
- **Conclusion:** answers the aim
- It is important that all is clear and concise

Deriving a relationship

Linear relationship – straight line graph

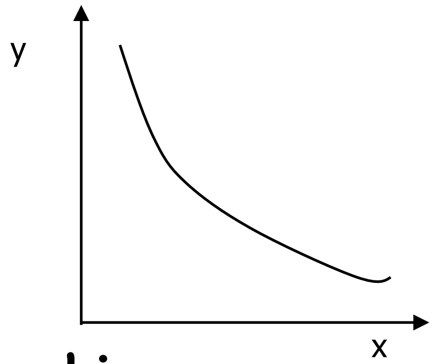
- $y \; \alpha \; x$ (y is directly proportional to x)

» Equation : $y = mx + c$



Non linear relationships

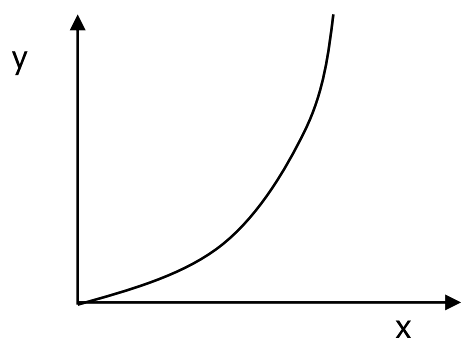
- **Inverse relationship:** $y \ \alpha \ \frac{1}{x}$ or y is inversely proportional to x
  or y is proportional to the inverse of x

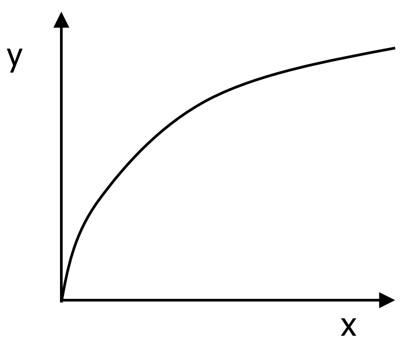


- **Square relationship** :

$y \ \alpha \ x^2$ or $y^2 \ \alpha \ x$ $(y = \sqrt{x})$

y is prop to square of x   x is prop to square to square of y

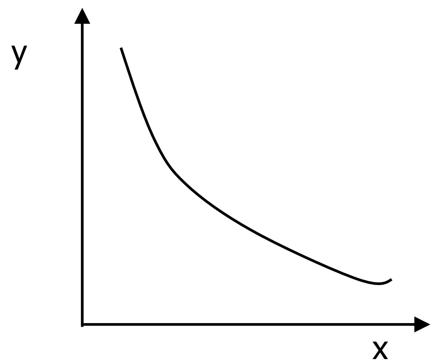


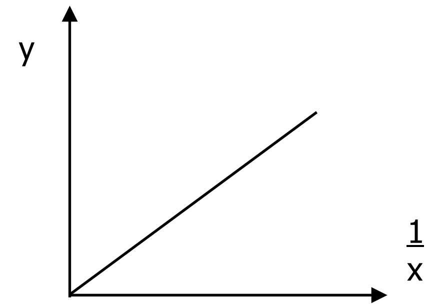


To be able to write an equation for a relationship you need a straight line graph.

- For an inverse graph , calculate the inverse of x and add to table.

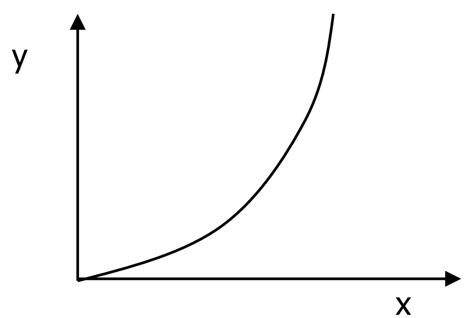
plot y vs $\frac{1}{x}$

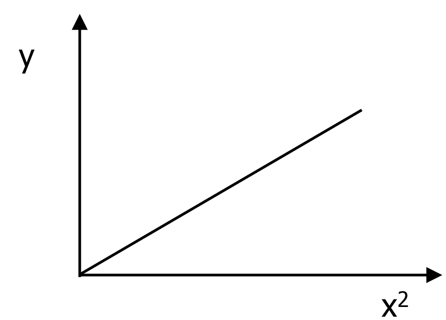




- For a square $y \propto x^2$; calculate x^2 and tabulate

plot y vs x^2





- For a square $y^2 \alpha x$; calculate and add to table.
  plot y^2 vs x.